32. The results of the study show that there are significant sharing opportunities for fixed stations in the Amateur Radio Service at 216-220 MHz, even assuming protection criteria based on worst-case protection ratios. With respect to maritime mobile operation, the study concludes that co-channel operation would require up to 120 km of distance separation between, for example, an amateur packet transmitter and a maritime receiver. The distance separation falls off rapidly , as separations required to prevent interference to a maritime mobile receiver are relatively small, assuming more than 100 kHz of offset. Assuming 200 kHz of offset, approximately 30 km of separation is required. In real applications, where the 12 dB of additional discrimination would be available from orthogonal polarization or use of directional antennas at the amateur stations, co-channel sharing could be done at distances of approximately 70 km.

33. Any land mobile assignments in the 216-220 MHz band can be protected with a maximum, worst-case distance separation, co-channel, of 161 km from land mobile receiver to amateur packet transmitter. In this case, only 200 kHz of separation between land mobile receivers and amateur packet transmitters reduces the geographical separation to 37 km. In a typical installation, however, approximately 90 km of separation would be necessary on a co-channel basis; far less for stations separated by 200 kHz.

34. Telemetry assignments require the smallest frequency and distance separations. Co-channel assignments require, worst-case,

under 70 km of separation, and only 8 km with 200 kHz of frequency separation.

35. Radiolocation assignments, generally NAVY SPASUR receivers, should be protected from co-channel amateur packet stations by 317 kHz, worst-case. With 200 kHz separation, 29 km or less may be necessary. A realistic analysis of the interference potential reveals that no more than 130 km of separation would normally be required where polarization and non-mainbeam coupling factors are involved.

36. Distance separations to protect IVDS receivers (proposed for either the 218.0-218.5 MHz or the 218.5-219 MHz segment) are as much as 170 km, worst-case, though 200 kHz separation reduces that distance to less than 25 km. Realistic parameters would reduce the co-channel separation required to 65 km.

37. AMTS receivers require separation from co-channel amateur packet transmitters of less than 92 km. In typical cases where 12 dB of discrimination is available, the distance separation is reduced to less than 50 km.

38. With respect to television, the conclusions of this study were quite optimistic. Using worst-case assumptions, and because at 216 MHz, the frequency separation from the video carrier of television channel 13 is 4.75 MHz, the minimum distance separation is up to 11 km from the grade B contour of the TV station. However, assuming frequency separations greater than 6.75 MHz, (amateur operation above 218 MHz), distance separations are reduced to less than 8 km. Further examination of TV receiver selectivity details

show that co-location of amateur transmitters and TV receivers at grade B contour is possible at certain frequencies in the 216-220 MHz range. Where higher TV signal strengths occur, such as within the Grade A contour, smaller frequency/distance separation is possible. When analyzed in realistic terms, cosite operation of amateur transmitters and television receivers should be possible above 216 MHz.

39. Aeronautical mobile stations should be separated from co-channel amateur packet transmitters, worst case, by 341 km. 200 kHz of off-tuning reduces that distance to less than 200 km, and, for non-packet stations, i.e. fixed links, the distance separation is reduced to less than 29 km. Realistically, the co-channel distance separations would be considerably less.

40. Fixed stations should be separated from co-channel amateur packet stations by 80 km. Additional frequency separation provides gradual additional attenuation. Assuming the availability of 12 dB of additional discrimination, the distance separation reduces to less than 45 km in typical cases, co-channel.

41. The conclusions of the study with respect to amateur receivers show that the distance separations for other services are similar to those applicable to amateur receivers. Ultimately, the study concludes that, because band use of 216-220 MHz is sparse, the Amateur Radio Service could effectively operate in the 216-220 MHz band subject to appropriate frequency and distance separation constraints. The study affirms that substantial spectrum resources would be available to the Amateur Service in the band, even if

usage of the band by the other incumbent services grows substantially beyond the levels shown in the study. Imposition of technical standards, e.g. power limits, in the Amateur operation in the band could theoretically help bound the frequency/distance separations discussed in the study. The amateur radio community, it is concluded, will have to conduct frequency management activities in order to avoid any interference to its own, and other services', systems.

IV. Proposed Coordinated Amateur Operation at 216-220 MHz.

42. As noted above, the Amateur Radio Service was set back in the development of its national digital packet radio network by the loss of the 220-222 MHz band. The record in Docket 87-14 is clear that other bands cannot provide adequate substitute spectrum for the 220-222 MHz band, nor can the 222-225 MHz band assimilate displaced 220-222 MHz uses in most areas of the country. The Commission has invited the instant proposal, for fixed location, secondary amateur access to the 216-220 MHz band. The engineering studies conducted by the League and its consultants have revealed significant opportunities for sharing of the 216-220 MHz band with other services. The League thus requests that the Commission amend the domestic table of frequency allocations to provide for such use.

43. It would not be advisable for amateurs to be able to access the band without prior coordination with a spectrum manager or database administrator. This entity would develop and maintain

a database of current assignments to other services in the band, and would determine the advisable frequency constraints to prevent interference, on a case-by-case basis, for each planned amateur station. The League is willing to assume this function, and would provide advice to all amateurs desiring to initiate operations in this band, on a case-by-case basis, relative to the necessary station configurations to protect existing users. The League would also inform such amateur users of new, non-amateur systems in the band, to avoid interference to those services.

44. It is proposed that the Amateur Service Rules, as set forth in the attached appendix, would require that no amateur stations are permitted to operate in the 216-220 MHz band except on a non-interference basis to other users, and so long as there is no interference caused to broadcast reception on Channels 11 and 13 from such operation. The rules would provide that amateur operation may not be initiated in the band unless the amateur licensee either conducts his or her own spectrum analysis, or contacts the database administrator for a recommended frequency, if any, which is likely to avoid interference to other services in the band. The absolute responsibility to avoid interference would be placed on the amateur radio licensee. This arrangement is similar to the frequency coordination effort conducted in the private sector for Part 74 users in the Broadcast Auxiliary Service. Finally, the League has proposed a power limitation of fifty watts PEP, unique to the 216-220 MHz band in order to further reduce the potential for interference to stations in other services, including AMTS.

45. In this way, the Commission will suffer no administrative burden, nor would the licensees in other services, nor the television Channel 11 or 13 users. More efficient use of the radio spectrum would be occasioned thereby, and the Amateur Radio Service would regain at least some of that which was lost by the reallocation of the 220-222 MHz band.

V. Conclusion

46. The Commission is in the midst of planning for the future use of the 216-220 MHz band, with the recent decision to expand the AMTS systems nationwide, and the possible initiation of new IVDS service. The League takes no position herein on the relative merits of the latter service. Even if the service is initiated by the Commission, it is unclear what the relative use of such a system will be versus cable-provided IVDS. Regardless, it is apparent that significant additional use can be made of the 216-220 MHz band by amateurs, now and in the future. The League is willing to coordinate, through continued database management, any amateur operation initiated in the band, and assist in resolving any interference problems which may arise. The League can be contacted by any non-amateur user of the band to register interference complaint, which will be addressed immediately by contacting the amateur licensee involved. This way, there will be no administrative burden to any user, or to the Commission.

Therefore, the foregoing considered, the American Radio Relay League, Incorporated respectfully requests that the Commission initiate, at the earliest possible date, a rule making proceeding proposing to allocate the 216-220 MHz band to the Amateur Radio Service on a secondary, non-interference basis; and to amend the Amateur Radio Service rules, all in accordance with the attached appendix, to provide for coordinated amateur use of the band on a non-interference basis.

Respectfully submitted,

THE AMERICAN RADIO RELAY LEAGUE, INCORPORATED

225 Main Street
Newington, CT 06111

By Christopher D. Imlay
Its Counsel

BOOTH, FRERET & IMLAY
1920 N Street, N. W.
Suite 150
Washington, D. C. 20036
(202) 296-9100

June 4, 1991

EXHIBIT A

EXHIBIT A

American Radio Relay League
Technical Department Laboratory
Newington, CT 06111

INTERFERENCE TO TELEVISION CHANNELS 11 AND 13 FROM TRANSMITTERS OPERATING FROM 216 MHz to 220 MHz

June 21, 1990

SUMMARY

The purpose of this study was to determine the interference potential of Amateur Radio transmitters operating in the 216- to 220-MHz band to typical television receivers tuned to over-the-air signals found in residential areas at ranges likely to be encountered in a residential setting. Subjective tests of 5 television receivers, chosen to represent those typically found at present in homes, indicate that television reception on channel 13 could be perceptibly affected by strong signals within the frequency range of 216 to 218 MHz. The test results show that this effect is less pronounced within the frequency range of 218 to 220 MHz. A minimal effect on channel 11 was noted under test conditions designed to test for intermodulation effects between a channel-13 television signal and a signal in the range of 216 to 220 MHz.

This report presents graphical data that allows estimations of interference potential to channel 13, and to some extent to channel 11, from transmitted signals in the 216 to 220 MHz range. The data are in fair agreement with the data presented in a 1975 FCC study. An improvement in television-receiver performance since 1975 was noted.

The Project Engineer engaged in this study was Edward Hare (KA1CV), Laboratory Engineer at the American Radio Relay League's Technical Department. The study was reviewed and approved by Jonathan Bloom (KE3Z), Laboratory Supervisor at the League's Technical Department, and by Charles Hutchinson (K8CH), the Technical Department Manager.

INTRODUCTION

In order to determine the proper operating parameters for Amateur Radio communications in the 216- to 220-MHz band, the susceptibility of television receivers to overload from strong adjacent-service transmitters was studied. One receiver was also tested with a input-signal level of a grade-B contour television signal for susceptibility to signals in the frequency range of 220 MHz to 225 MHz, in order to relate our interference-potential findings at 216 to 220 MHz to the interference potential of the present Amateur Radio operations at 220 to 225 MHz.

Additional tests were also performed to determine whether there would exist any intermodulation effect between channel-13 television signals and signals in the frequency range of 216 to 220 MHz. These additional tests were performed on two television receivers tuned to a television signal on channel 11.

TEST PROCEDURE

Five television receivers were chosen from a selection of previously owned receivers available at a local consumer-equipment rental business. The receivers were chosen represent both switched-LC and varactor tuners. Each television was made by a different manufacturer. The receivers selected represent those television receivers typically found at present in residences. No filters or other modifications were added to the receivers.

Table 1 describes the receivers tested.

Receiver Number	Manufacturer	Model Number	Tuner Type
1	Goldstar	CR-402	LC-switched
2	General Electric	13AC1542W	LC-switched
3	Toshiba	C990	LC-switched
4	Magnavox	BC4173WA02	Varactor
5	Quasar	WT5943WW	Varactor

Table 1 — Television receivers tested

Signal generation

The block diagram for the channel-13 interference-susceptibility test is shown in Figure 1. The resulting television-signal quality was equal to that of a typical home VCR picture.

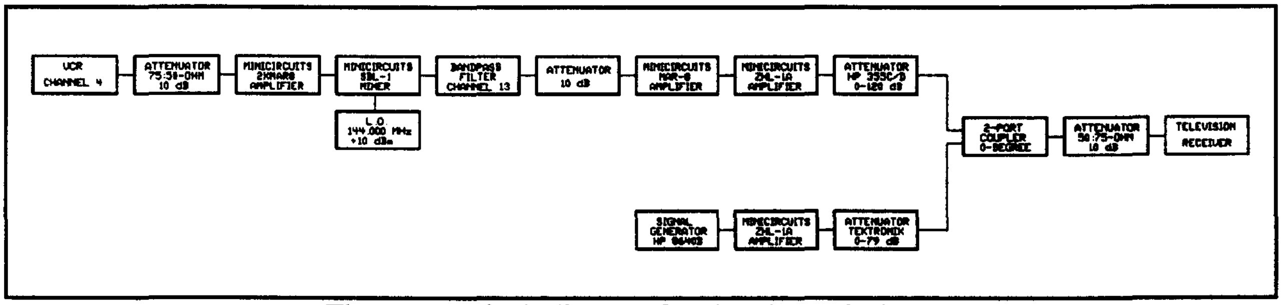

Figure 1—Block diagram for the channel-13 tests

The block diagram for the channel-13 with channel-11 interference-susceptibility test is shown in Figure 2. The resulting television-signal quality was equal to that of a typical home VCR picture.

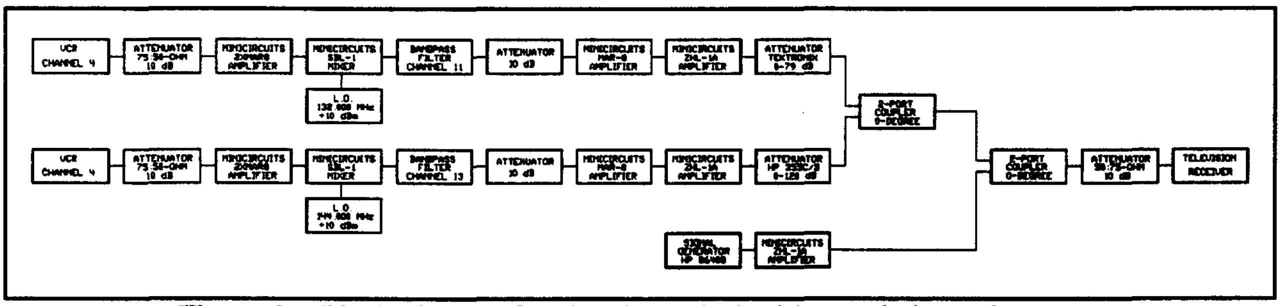

Figure 2—Block diagram for the channel-13 with equal channel-11 tests

CONDITIONS OF OBSERVATION

One observer was present to determine the level of signal at 216 to 220 MHz that would be sufficient to cause a perceptible change to the television picture, color or sound. The observer was not specifically trained, but was self-characterized as being demanding about picture quality. One observer was deemed sufficient, based on data discussed in a similar 1975 FCC Laboratory Division study. [See Davis and Middlekamp, "Interference to TV Channels 11 and 13 from Transmitters Operating at 216 to 225 MHz. FCC Laboratory Division, Project No. 2299-71 (1975), hereinafter referred to as the "1975 FCC Study."][1]

The observer viewed the television screen at a distance of approximately 5 picture heights from the television receiver. The room was illuminated by a 100-watt incandescent bulb in a shaded fixture. Care was taken to ensure that there were no distracting reflections on the television-receiver screen. These conditions represent ambient conditions for television viewing in a typical home environment.

For the channel-13 interference-susceptibility tests, the television was tuned to channel 13, using a television-signal level of -45 dBm. For the channel-11 with equal-level channel-13 tests, the television receiver was tuned to channel 11, using a television-signal level of -45 dBm. Each time, the receiver controls were adjusted by the test engineer. The untrained observer concurred each time that the control settings resulted in a desirable picture and sound.

The television-signal level was then set to -65 dBm. The level of adjacent-service signal that resulted in perceptible alteration of the video, color or audio characteristics of the television signal was determined for transmitting frequencies from 216 to 220 MHz in 0.5 MHz steps, using unmodulated, continuous-wave emissions from the signal generator. The 216- to 220-MHz signal was cycled on and off at the request of the untrained observer. This procedure was repeated for television-signal levels up to -5 dBm, in 10 dB steps. These signal levels were chosen to include a signal weaker than a grade B contour signal level and a strong signal greater than that typically received at television receivers in home use.

Data were recorded only at the discrete 0.5 MHz steps. A review of the 1975 FCC Study indicated that there is no significant difference in receiver susceptibility to FM or CW signals, so only CW 216- to 220-MHz signals were used. The test conditions and methods were modeled after those described in the 1975 FCC Study.

RESULTS AND ANALYSIS

Channel 13 television signal with one adjacent-service signal (216-220 MHz)

The results of the tests are presented in graph form. Figure 3 is the graph depicting a -55 dBm (grade B contour) channel 13 television signal. The vertical scale represents the level of adjacent-service signal that resulted in perceptible alteration of the video, color or audio characteristics of the television signal.

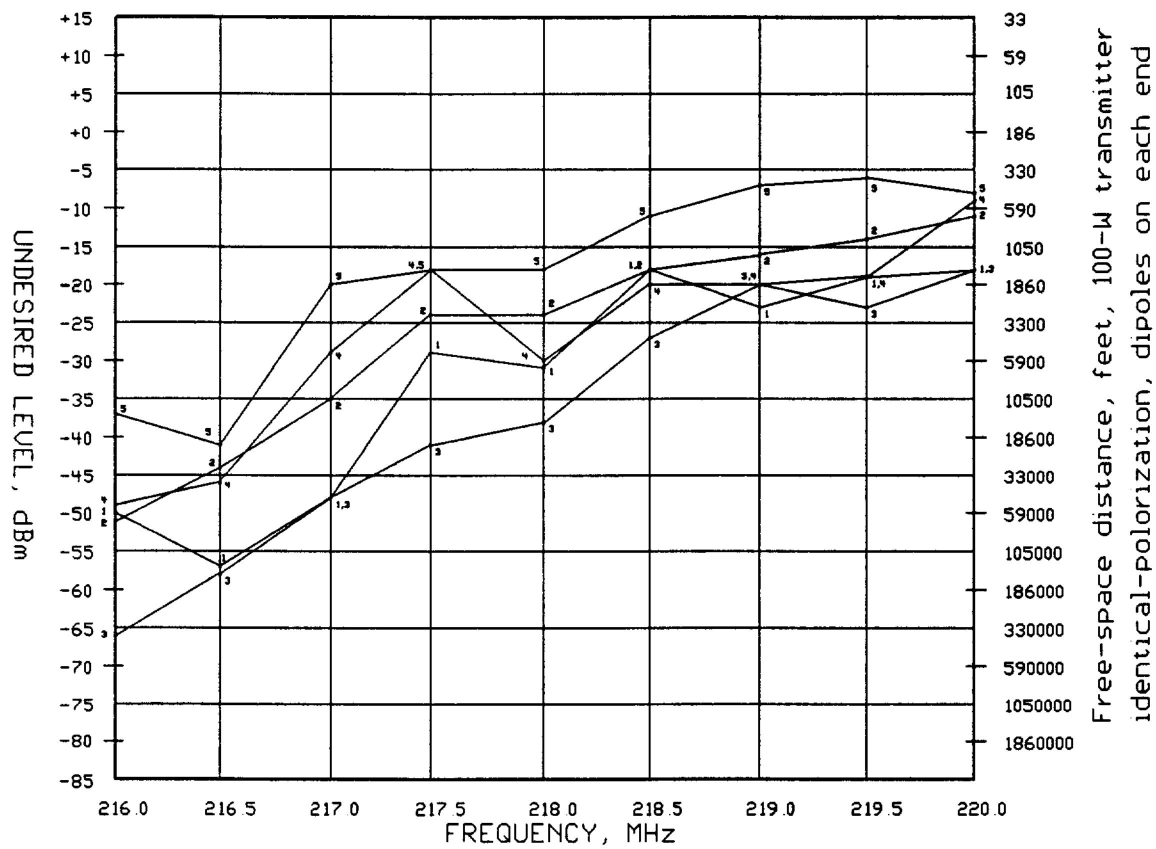

FIGURE 3 INTERFERENCE SUSCEPTIBILITY RCVRS 1-5
CHANNEL 13 AT -55 dBm

The vertical labeling on the left side of Figure 3 expresses the level of adjacent-service signal, expressed in dBm, that resulted in a perceptible change to the television reception. The vertical labeling on the right side expresses this same level in the amount of distance separation in feet between a 100-watt transmitter at the frequency of the adjacent-service signal and a television receiving antenna. Free-space attenuation and half-wave horizontal dipoles are assumed at both transmitter and receiver.

The data for the remainder of the tests are presented on the graphs Figures 4 through 13. The labeling for distance separation has been omitted from these graphs.

The curves generally show a rapidly diminishing interference potential as the adjacent-service signal moves from 216 MHz toward 218 MHz. The susceptibility is reduced more slowly as the adjacent-service signal varies from 218 MHz toward 220 MHz. The 1975 FCC Laboratory study was conducted from 216 to 225 MHz. It shows that the susceptibility is reduced even more slowly as the signal varies from 220 MHz toward 225 MHz. One of the television receivers was tested over the frequency range of 216 to 225 MHz. The results of this test are shown on Figure 13, found in the group of graphs at the end of this report. On the average, the interference susceptibility of the television receivers tested is 7 dB better than in the 1975 FCC study over the frequency range of 216 to 220 MHz. The average susceptibility was obtained with the formula:

$$\frac{1}{N}\sum_{i=1}^{N} p_i$$

where p_i is the interfering power level (in dBm) for receiver i.

The assumptions for the distance separation figures represent the worst-case conditions. Factors that would modify these figures, such as cross-polarization between the transmitting antenna and the television antenna, use of transmitting directional antennas with a null in the direction of the television receiving antenna, or the use of a gain type television receiving antenna, would tend to lessen the actual interference potential.

The test engineer noted that above 218 MHz the change in television picture quality was predominantly manifested as a herringbone pattern. Below 218 MHz the change was predominantly manifested by a gradual fading of the color intensity.

Channel-11 television signal with equal-level channel 13, one adjacent-service signal 216 to 220 MHz

Figure 4 is the graph for a -55 dBm (grade B contour) channel-11 signal with an equal level channel-13 television signal. The vertical scale represents the level of adjacent-service signal that resulted in perceptible alteration of the video, color or audio characteristics of the television signal.

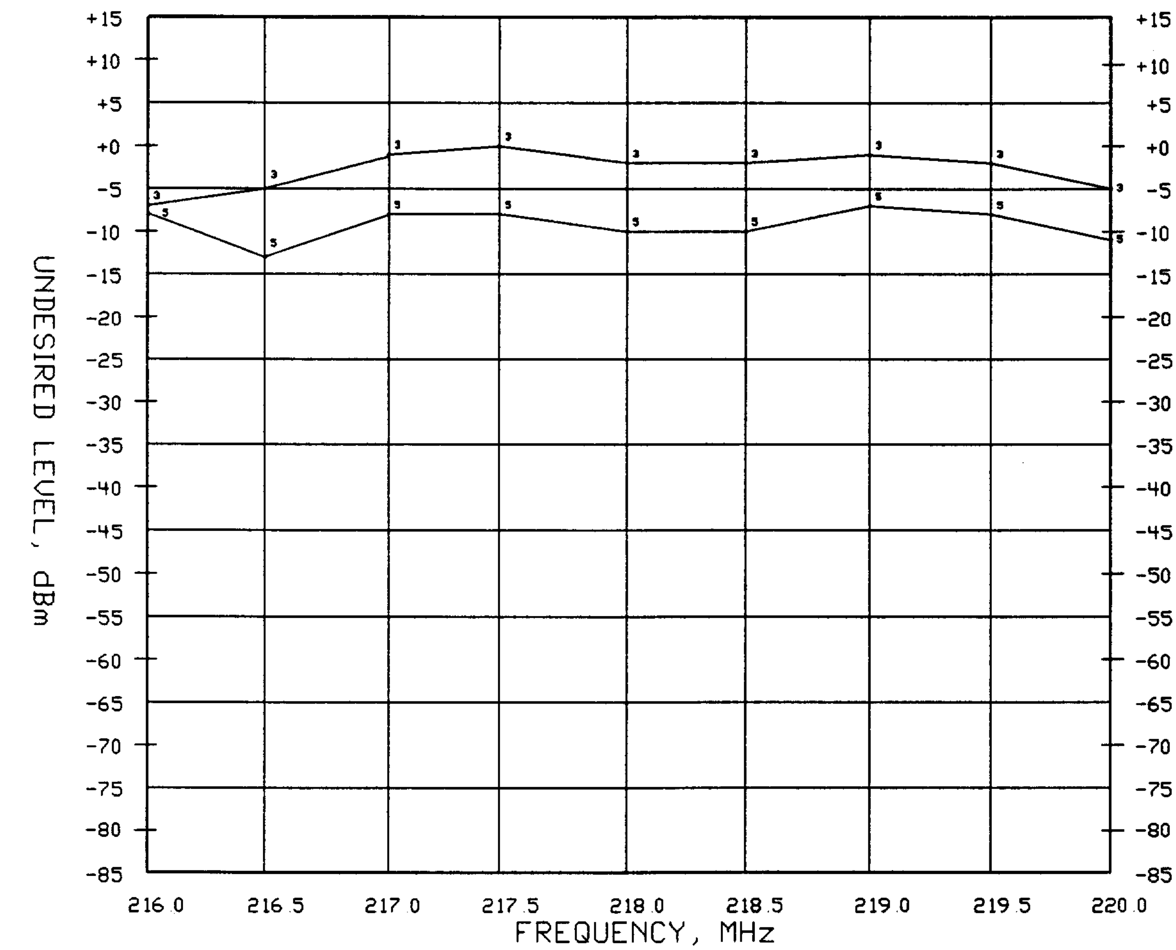

FIGURE 4: INTERFERENCE SUSCEPTIBILITY, RCVRS. 3 AND 5
CHANNEL 11 AT -55 dBm WITH EQUAL LEVEL CHANNEL 13

This test was also performed at a television-signal level of -45 dBm. The results for the -45 dBm test are shown on Figure 12, found in the group of graphs at the end of this report.

CONCLUSIONS

This report presents graphical data that allows estimations of interference potential to channel 13, and to some extent to channel 11, from transmitted signals in the 216 to 220 MHz range. The data are in fair agreement with the data presented in a 1975 FCC study. An improvement in television receiver performance since 1975 was noted.

Notes

[1] Interference to TV Channels 11 and 13 from Transmitters Operating at 216 to 225 MHz. FCC Laboratory Division. Project No. 2299-71. Davis and Middlekamp

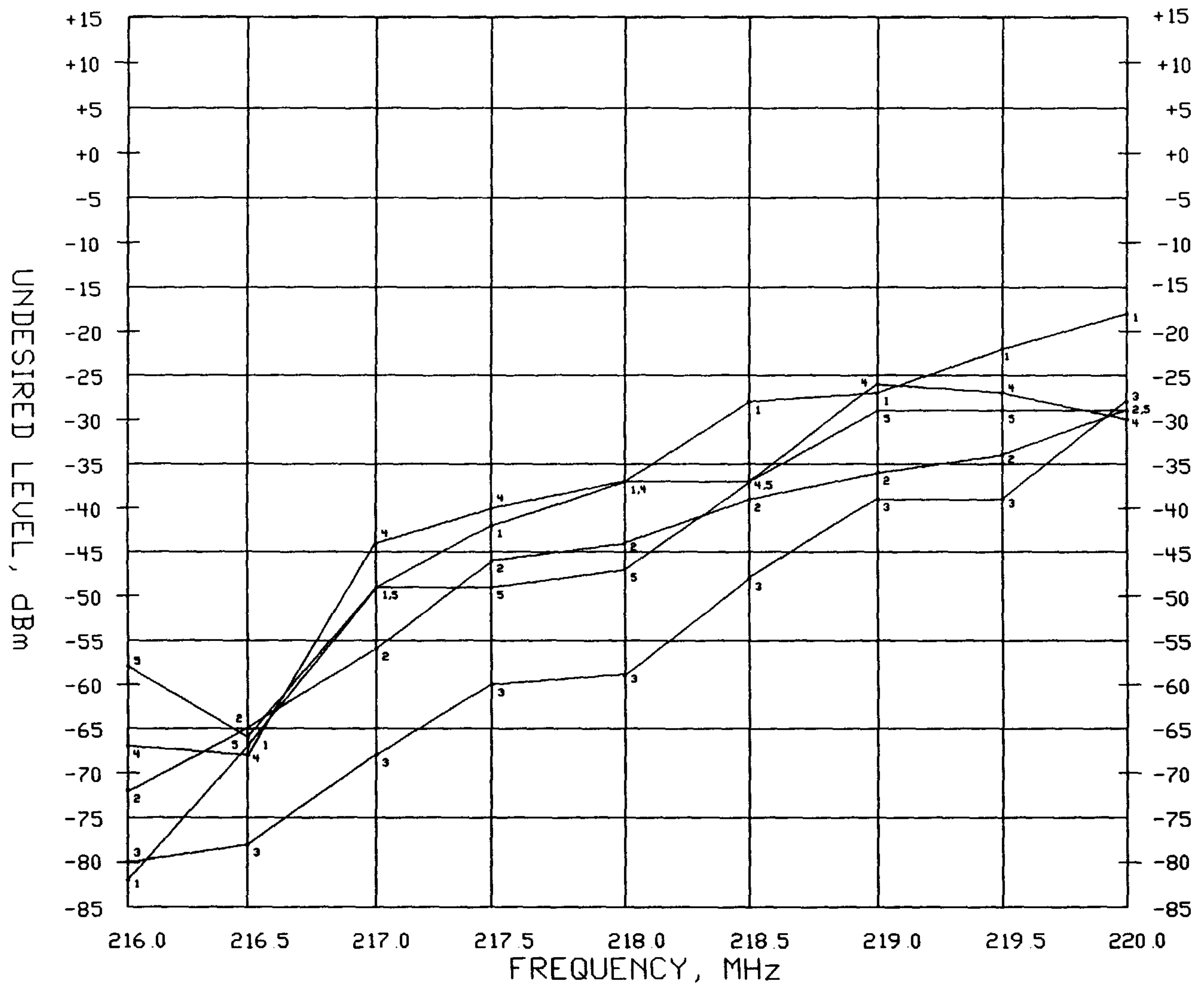

FIGURE 5: INTERFERENCE SUSCEPTIBILITY, RCVRS. 1-5
CHANNEL 13 AT -75 dBm

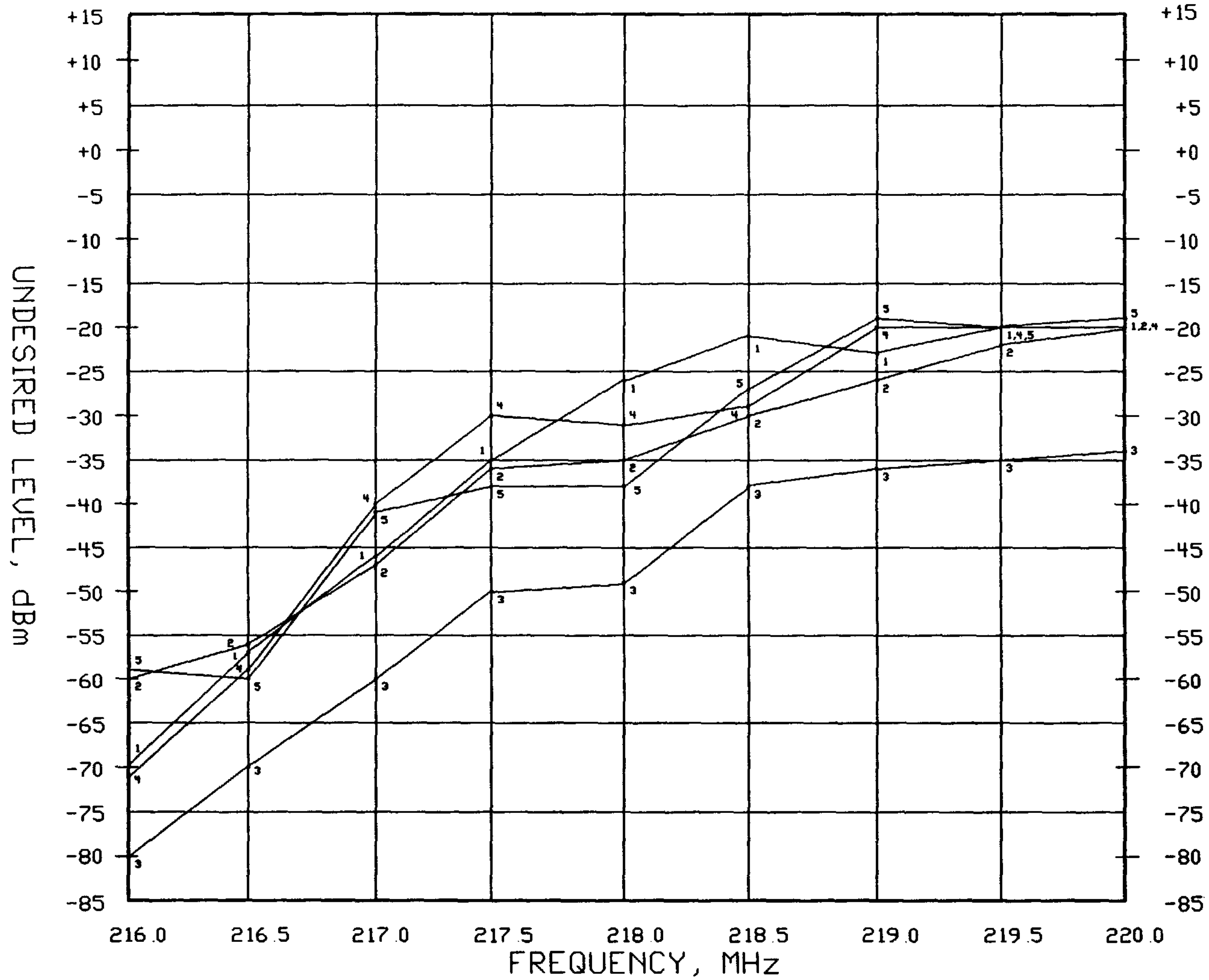

FIGURE 6: INTERFERENCE SUSCEPTIBILITY, RCVRS. 1-5
CHANNEL 13 AT -65 dBm

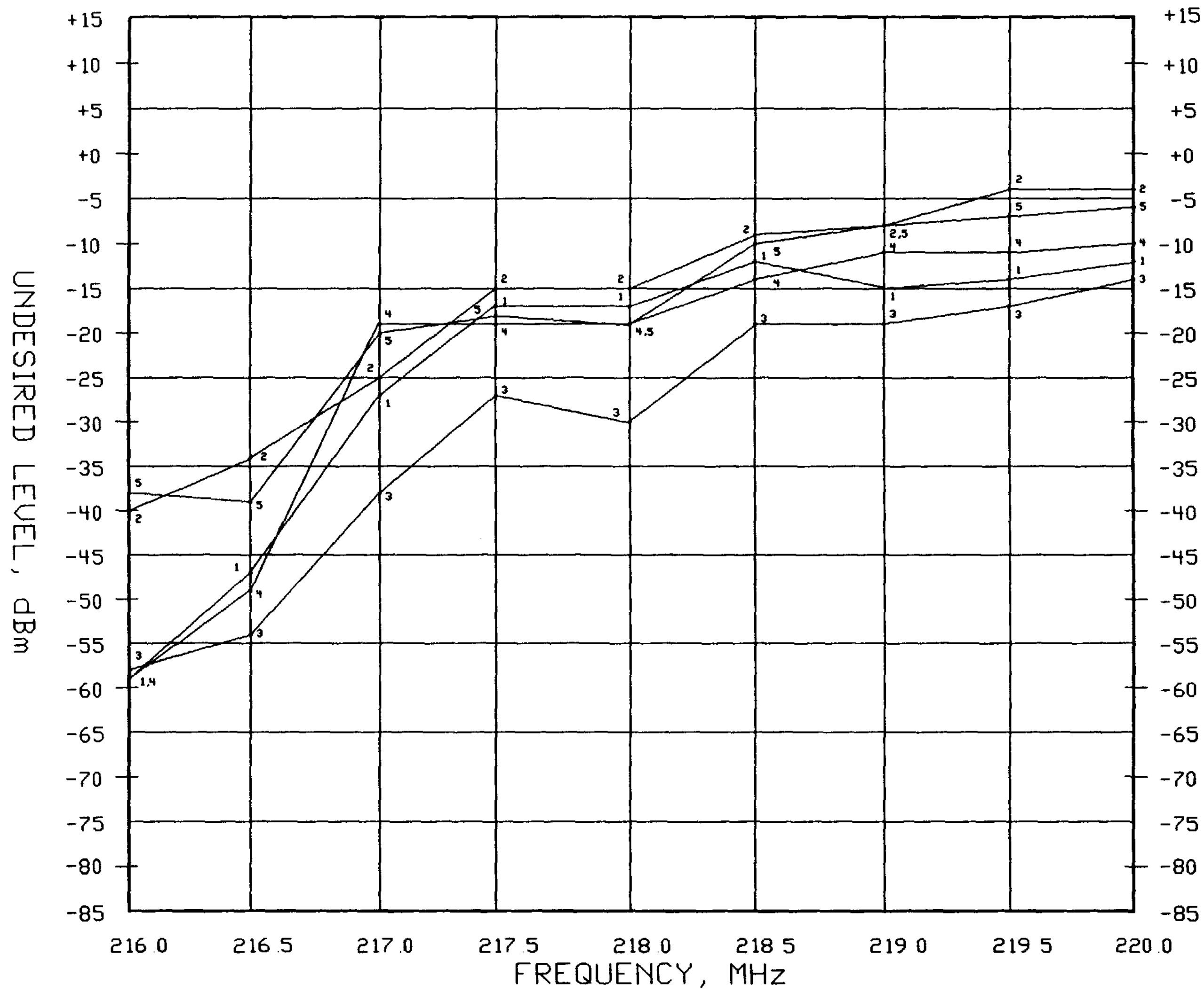

FIGURE 7 INTERFERENCE SUSCEPTIBILITY, RCVRS 1-5
CHANNEL 13 AT -45 dBm

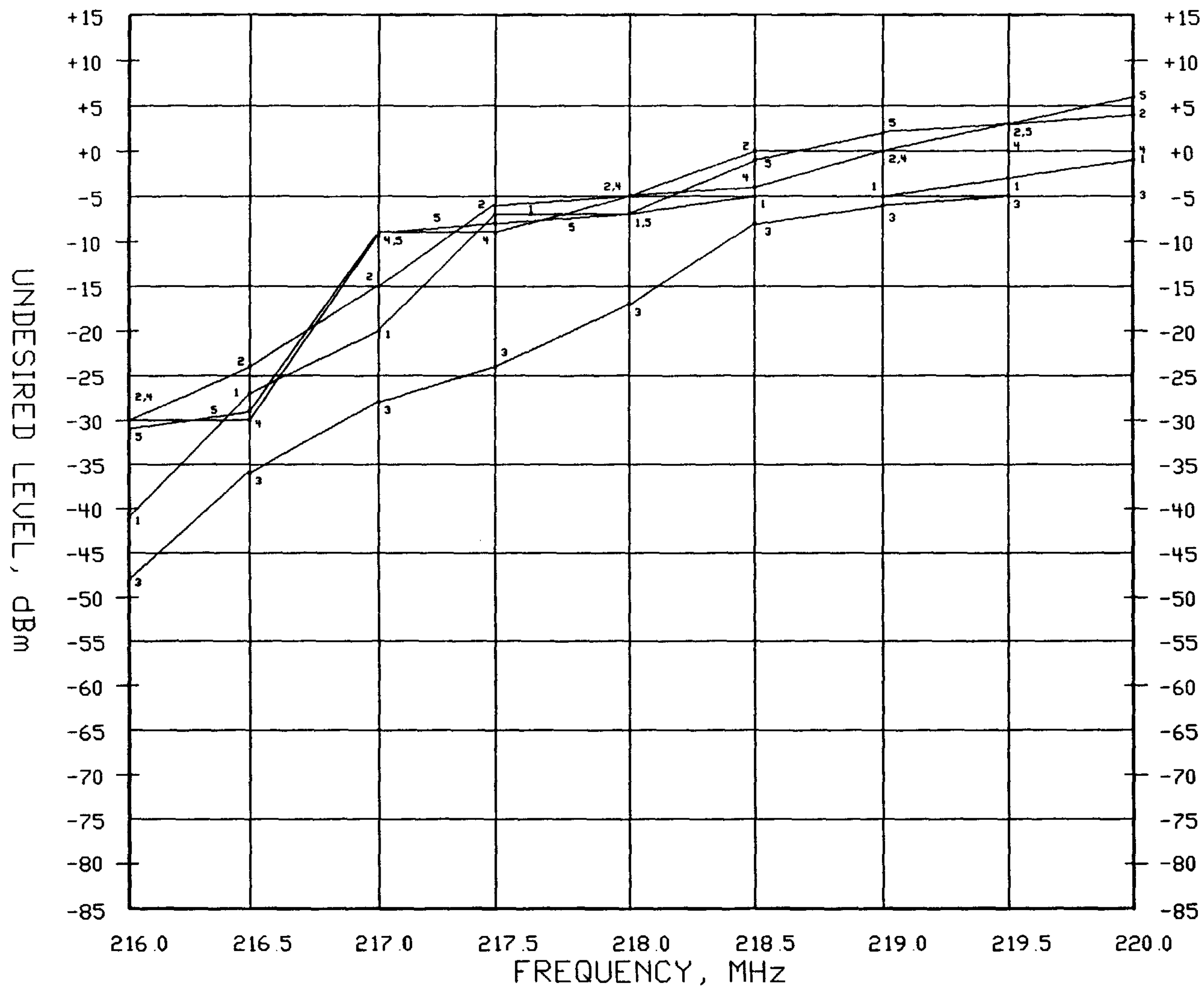

FIGURE 8: INTERFERENCE SUSCEPTIBILITY, RCVRS. 1-5
CHANNEL 13 AT -35 dBm

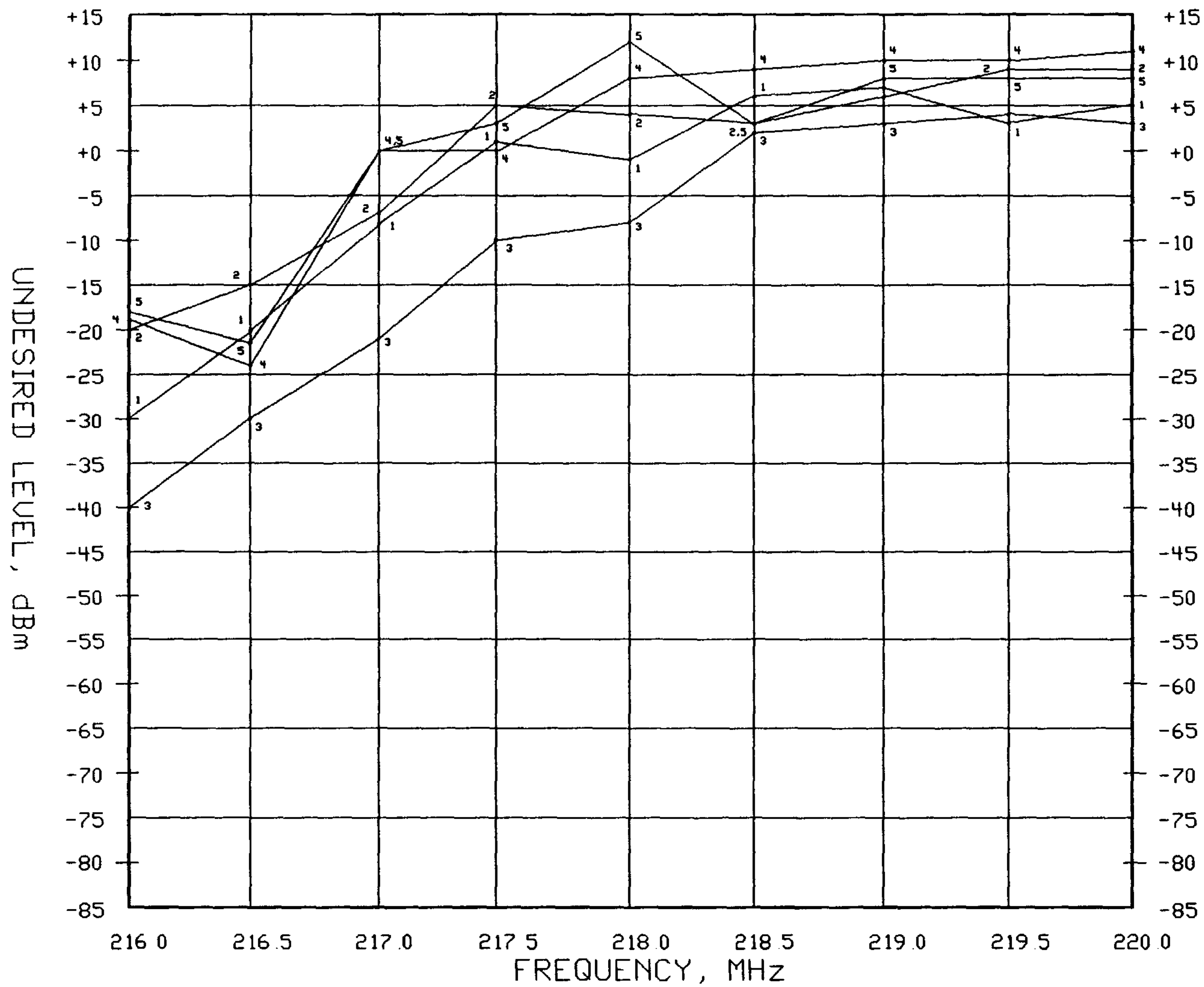

FIGURE 9 INTERFERENCE SUSCEPTIBILITY, RCVRS 1-5
CHANNEL 13 AT -25 dBm

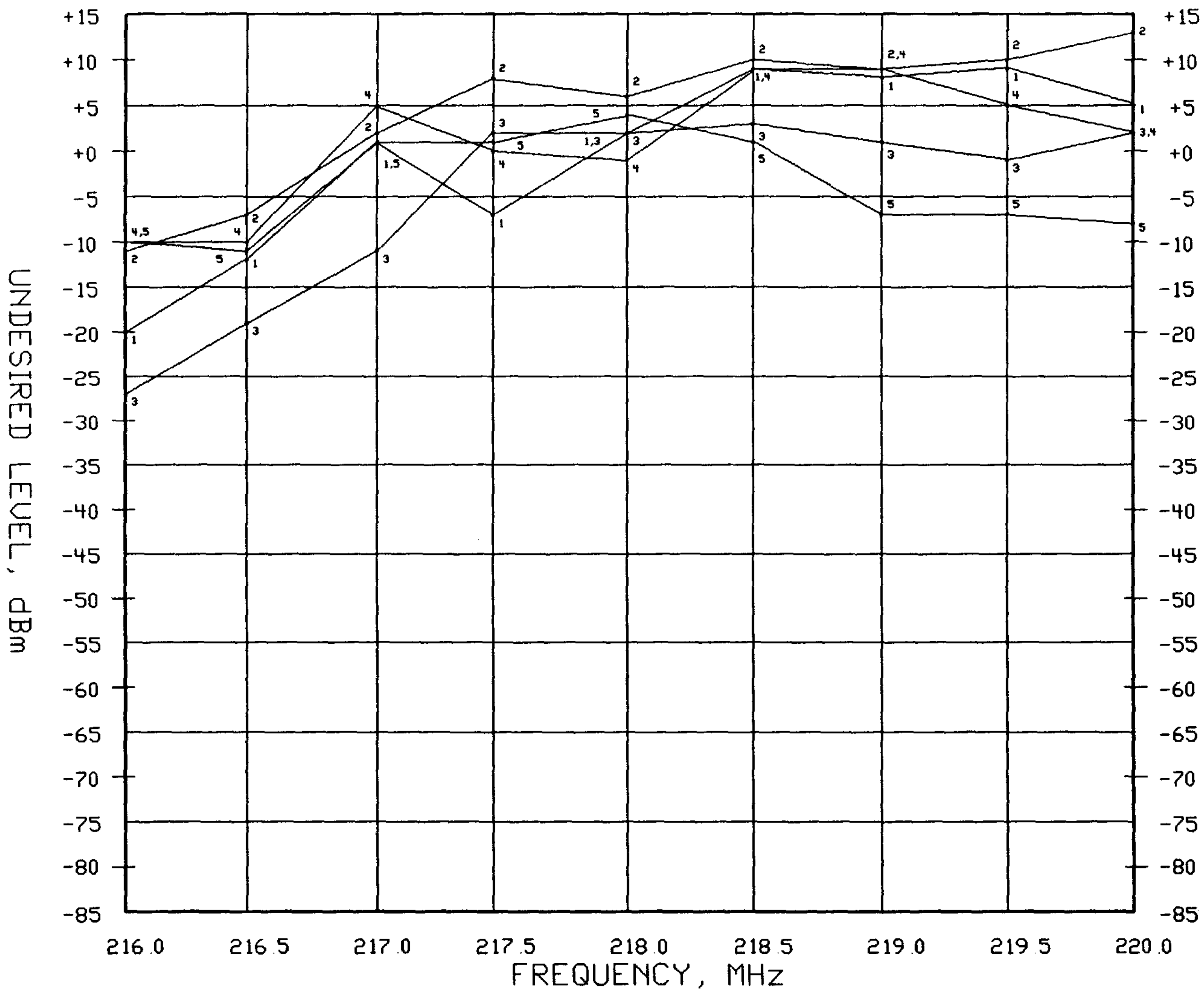

FIGURE 10 INTERFERENCE SUSCEPTIBILITY, RCVRS. 1-5
CHANNEL 13 AT -15 dBm

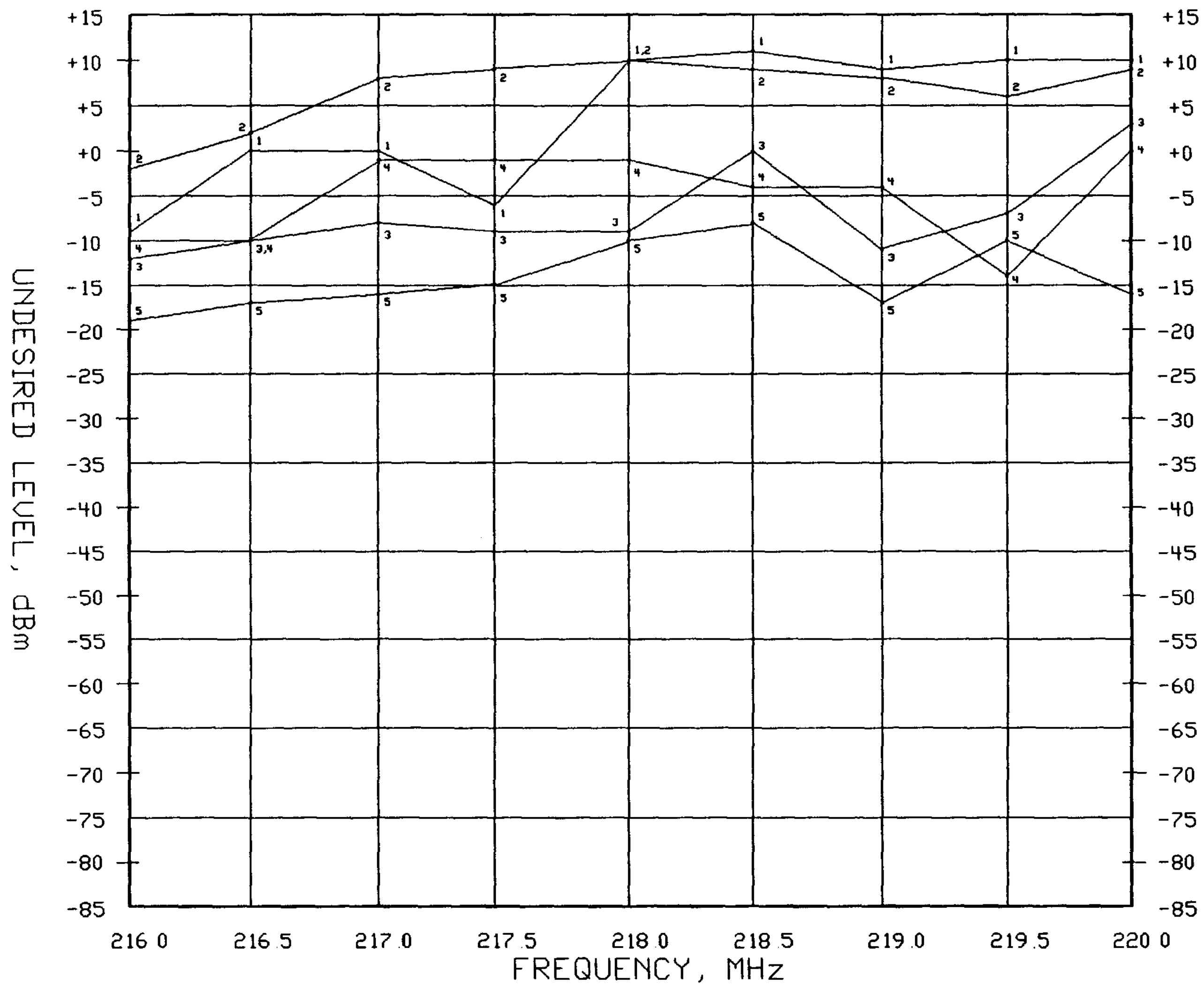

FIGURE 11: INTERFERENCE SUSCEPTIBILITY, RCVRS. 1-5
CHANNEL 13 AT -5 dBm

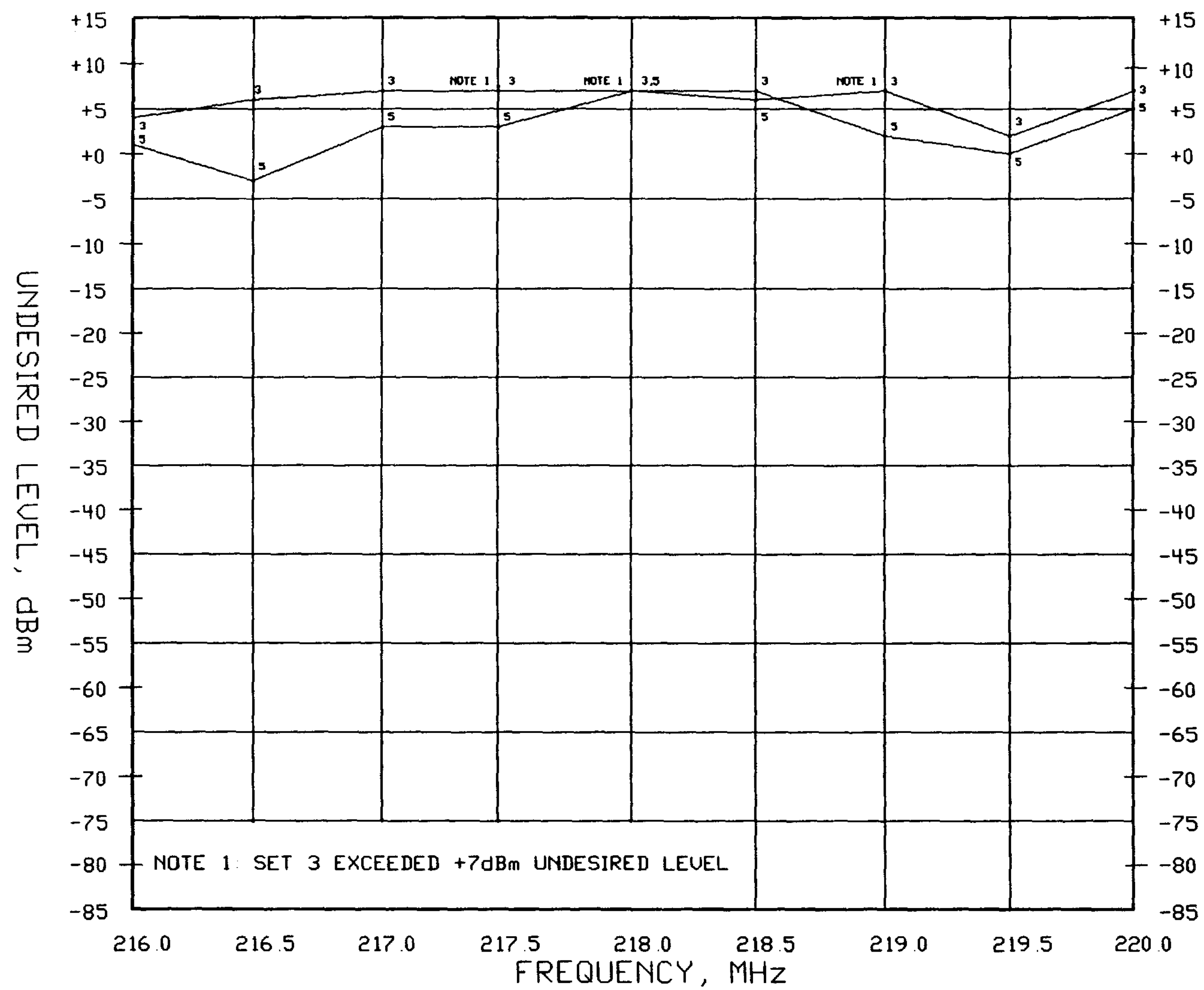

FIGURE 12: INTERFERENCE SUSCEPTIBILITY, RCVRS. 3 AND 5
CHANNEL 11 AT -45 dBm WITH EQUAL LEVEL CHANNEL 13

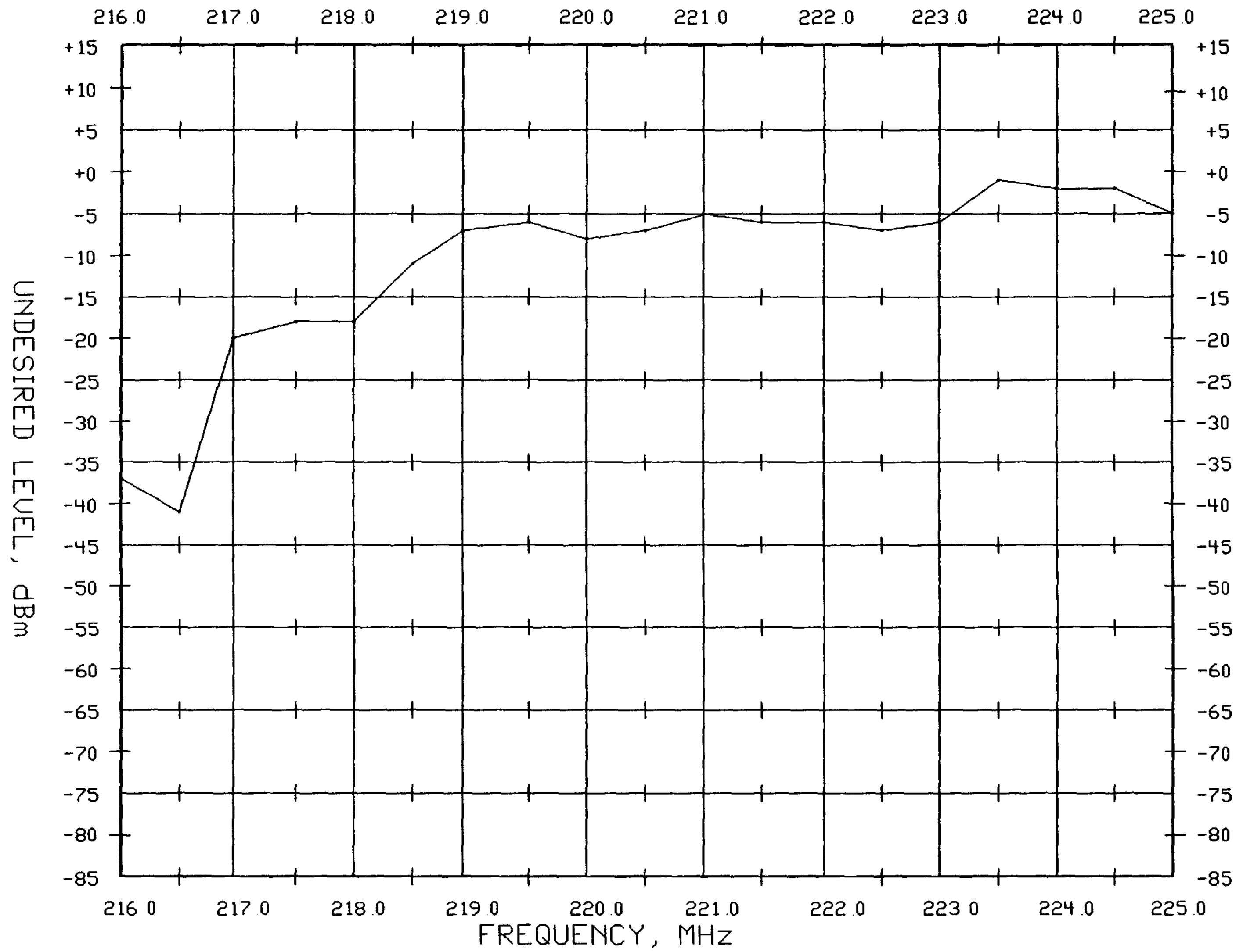

FIGURE 13 INTERFERENCE SUSCEPTIBILITY, RCVR 5
CHANNEL 13 AT -55 dBm